# A CLIMATOLOGY OF VERY INTENSE TYPHOONS:

# OR

# WHERE HAVE ALL THE SUPER TYPHOONS GONE?

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**Introduction**. The term super typhoon is a classification applied to tropical cyclones that reach 130 kt sustained one-minute average wind speed. The term is not a World Meteorological Organization (WMO) standard, but is used by the Joint Typhoon Warning Center, Guam (JTWC). In preparing the 1990 Annual Tropical Cyclone Report (ATCR), it was decided to make current A Climatological Study of Super Typhoons published in the 1970 Annual Typhoon Report (ATR, the predecessor of the ATCR) (JTWC, 1970) which included the years 1959-1970. Figures from that climatological study have been republished in various individual storm write-ups in succeeding ATR's/ATCR's and the study is frequently used in intensity forecasting.

At the outset such an update seemed fairly simple - using an interactive climatology of tropical cyclones of the western North Pacific developed by the Technique Development Group, Detachment 1, First Weather Wing, all tropical cyclones meeting the 130-kt criterion from 1971 through 1988 where identified. The 1970 Study identified 70 super typhoons during the period 1959-1970 for an average of 5.8 per year. The 1989 climatological search identified 48 for the period 1971-1988 for an average of 2.7 - less than half the number for the earlier period. Where had all the super typhoons gone?

**Background**. The 1970 Study identified super typhoons by applying the equation developed by Fletcher (1955) which correlated maximum sustained winds with recorded minimum sea-level pressure. The equation gives 944 mb as the equivalent sea-level pressure corresponding to 130 kt. Wind speeds in excess of 100 kt being subjective and the conservative nature of sea-level pressure made it the optimum parameter to use in classifying super typhoons.

The most often cited part of the 1970 Study is the figure depicting areas of 5°x5° squares of first super typhoon intensity occurrences (Figure 1). The 1970 Study found, between the Philippines and the northern Marianas, a double maxima separated by minimum area The super typhoon maxima were downstream from the minimum sea-level pressure double maxima found by Fung (1970). The 1970 Study also showed that super typhoon occurrence was normally distributed about the peak reached in September.

Subsequently Atkinson and Holliday (1975) developed a relationship between tropical cyclone minimum sea level pressure and maximum sustained winds. That relationship (reinforced by the results of (Lubeck and Shewchuck (1980))has become the standard relationship used by JTWC since. That relationship equates 130 kt with

approximately 910 mb.

Pressure was routinely available because of the availability of aircraft reconnaissance. Gradually satellite surveillance augmented, then replaced aircraft reconnaissance in 1987. Determination of intensity was either by satellite imagery using the procedures of Dvorak (1973, 1984), or by the occasional surface observation. Because pressure was no longer measured, intensities where determined from the Dvorak scale then pressure is derived from the Atkinson-Holliday relationship.

**Methodology**. Because of the advantages cited by the 1970 Study in using sea-level pressure, it was decided to use sea-level pressure once again to determine intensity. Because of the Atkinson-Holliday standard it was decided to use 910 mb as the criterion for selecting super typhoons; however, because the super typhoon criterion is very specific to 130 kt, the lack of super typhoon intensity data in the Atkinson-Holliday study, and to avoid conflict and confusion with super typhoon classifications within the JTWC and other archives, the term Super Typhoon will not be used instead a generic term - Very Intense Typhoons (VIT) will be used.

Aircraft reconnaissance and satellite surveillance data were culled from the Individual and Consolidated Typhoon Reports from 1950 through 1958 and the ATR's and ATCR's thereafter. All instances of a tropical cyclone reaching a central pressure of 910 mb was classified as a VIT. No attempt was made to determine the location of the first occurrence of 910 mb to other than 5°x5° square unless fix data crossed square boundaries. In those cases the fix data were linearly interpolated to locate the appropriate square. For aircraft fix data only measured central pressure from dropsonde data or the pressure derived from the 700-mb height using the relationship:

SLP= 645 + .115 * (700 mb height in meters)

was used. As aircraft data became scarce and was replaced by satellite derived intensities and the Atkinson-Holliday relationship, the first occurrence of 910 mb was taken from the first occurrence of Super Typhoon from the best track data published in the ATCR's.

**Results**. By using the more restrictive criterion of 910 mb, 83 tropical cyclones were classified as VIT's for the period 1950 through 1989 (Table 1). This is an average of 2.2 per year. While the double maxima is no longer evident (Figure 2), an axis of maximum occurrence remains between 15°- 20° north latitudes and there are indications of a primary lobe east 135° with a secondary lobe west of 140° with the axis of maximum occurrence pinched between 135° and 140° in which 48%. The axis of maximum occurrence corresponds to the axis of the Sub-Equatorial Ridge (SER) and is east of the East Asian Trough (EAT) (Guard, 1977).

The 1970 Study had found super typhoons normally distributed about a peak in September. The peak in VIT occurrence is in October (Figures 3 and 4).

There appears to be some consistancy in the VIT classification. Despite the changing fix platforms and procedures, the decadal average of VIT's remains relatively constant with the 60's being a below average decade and the 80's an above average decade and the 50's and 70's near average (Figure 5). However, since 1975 at least one VIT has occurred every year. This may be attributable to the the advent of the operational availability of satellite derived intensities (Dvorak, 1973).

## REFERENCES

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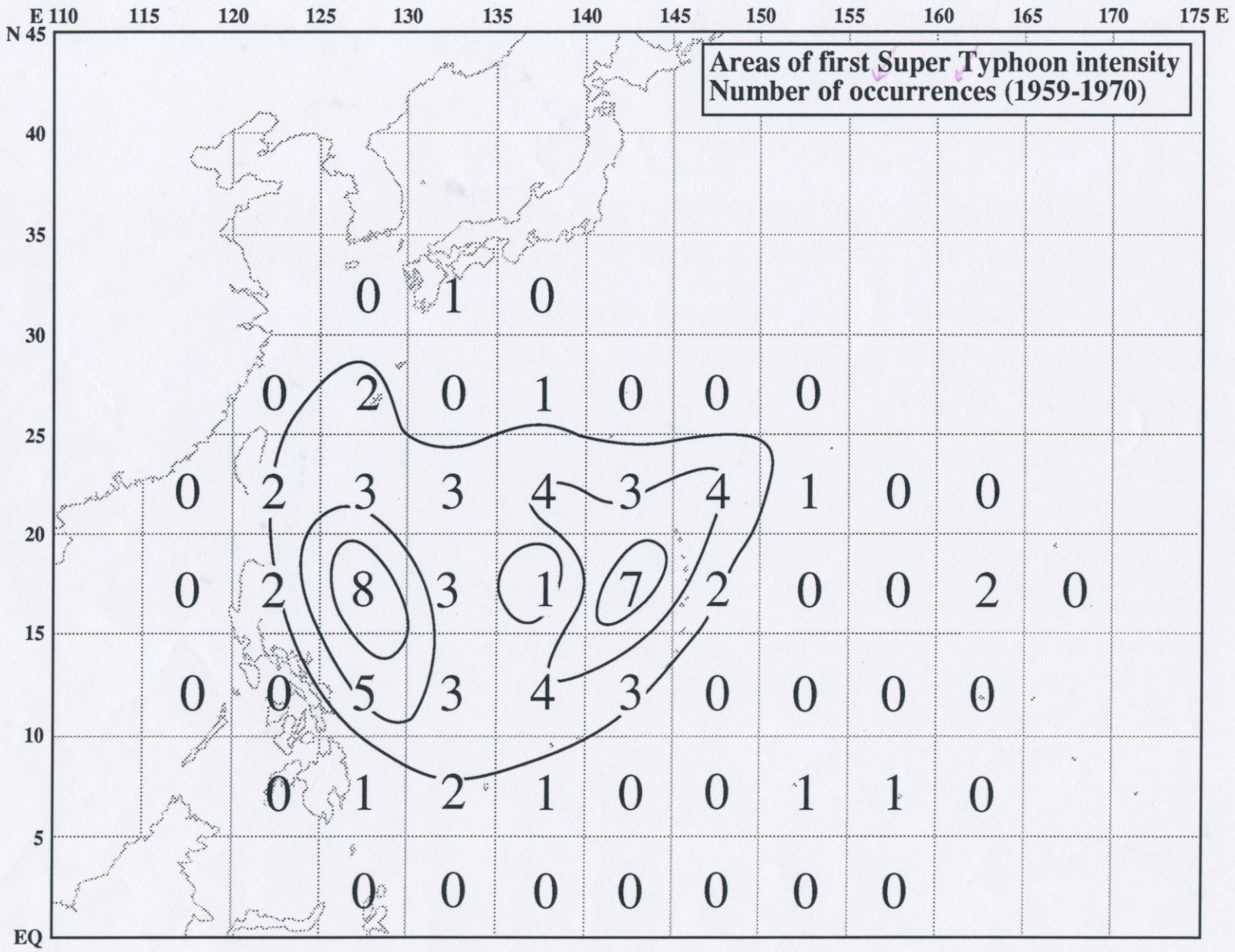
Areas of first Super Typhoon intensity
Number of occurrences (1959-1970)
E 110 115 120 125 130 135 140 145 150 155 160 165 170 175 E
N 45 40 35 30 25 20 15 10 5 EQ
0 1 0
0 2 0 1 0 0 0
0 2 3 3 4 3 4 1 0 0
0 2 8 3 1 7 2 0 0 2 0
0 0 5 3 4 3 0 0 0 0
0 1 2 1 0 0 1 1 0
0 0 0 0 0 0 0

Figure 1

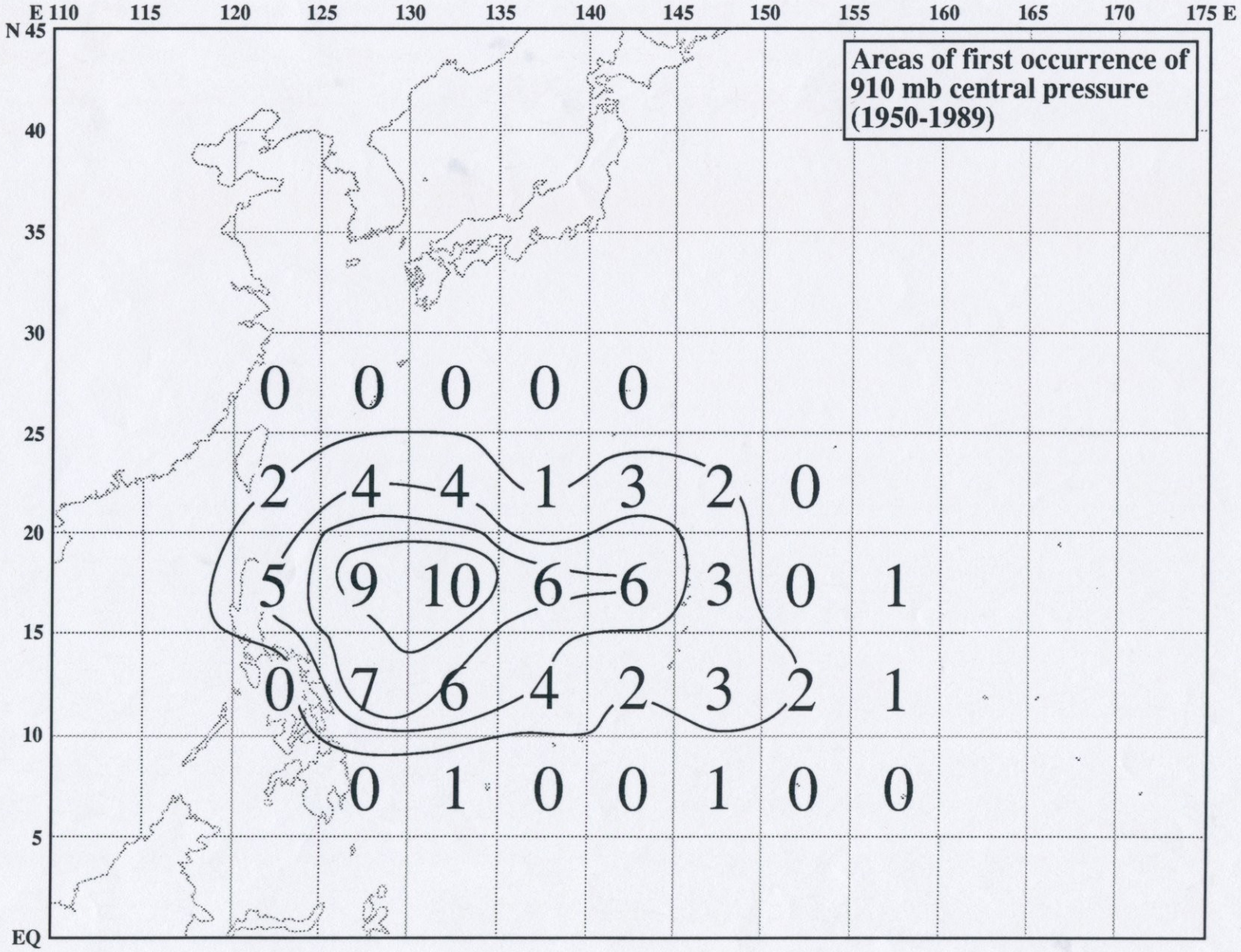
Areas of first occurrence of
910 mb central pressure
(1950-1989)
E 110 115 120 125 130 135 140 145 150 155 160 165 170 175 E
N 45 40 35 30 25 20 15 10 5 EQ
0 0 0 0 0
2 4 4 1 3 2 0
5 9 10 6 6 3 0 1
0 7 6 4 2 3 2 1
0 1 0 0 1 0 0

Figure 2.

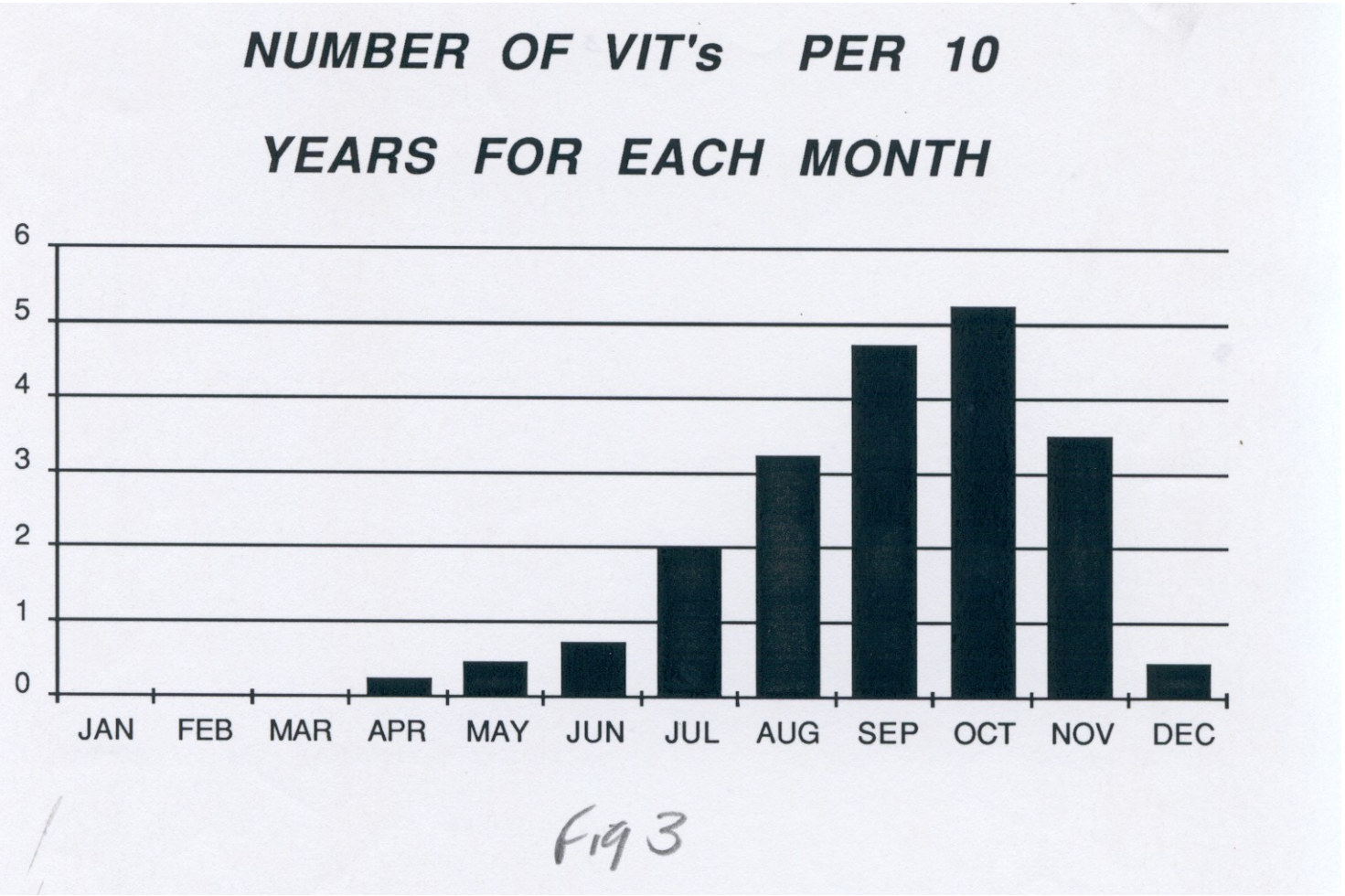
NUMBER OF VIT's PER 10
YEARS FOR EACH MONTH
6
5
4
3
2
1
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Fig 3

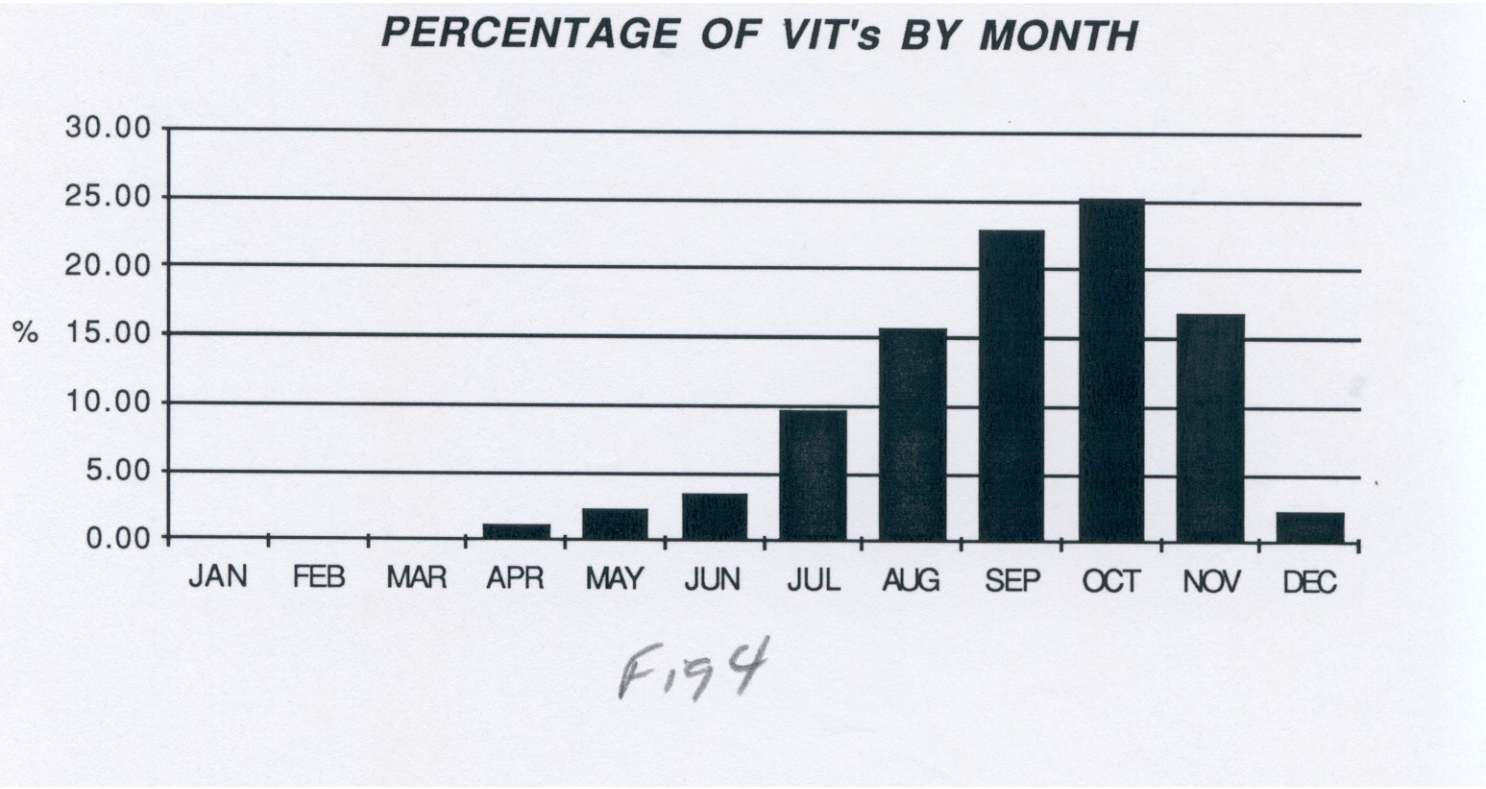
PERCENTAGE OF VIT's BY MONTH
30.00
25.00
20.00
%
15.00
10.00
5.00
0.00
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Fig 4

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | NAME | MONTH | MARSDEN SQF | YEAR | LOWEST SLP |
| 2 | OPAL | 8 | 962 | 62 | 910 |
| 3 | SHIRLEY | 7 | 962 | 60 | 908 |
| 4 | BETTY | 8 | 961 | 72 | 910 |
| 5 | NINA | 8 | 961 | 75 | 904 |
| 6 | BABE | 9 | 961 | 77 | 906 |
| 7 | SARAH | 9 | 961 | 59 | 905 |
| 8 | AGNES | 8 | 952 | 57 | 903 |
| 9 | TESS | 10 | 952 | 53 | 907 |
| 10 | NINA | 8 | 952 | 53 | 910 |
| 11 | MARGE | 8 | 952 | 51 | 908 |
| 12 | WILDA | 9 | 951 | 64 | 905 |
| 13 | HESTER | 10 | 942 | 57 | 886 |
| 14 | BESS | 9 | 942 | 65 | 901 |
| 15 | JUNE | 9 | 942 | 54 | 909 |
| 16 | HOPE | 9 | 941 | 70 | 895 |
| 17 | EMMA | 10 | 941 | 62 | 903 |
| 18 | GEORGIA | 9 | 604 | 70 | 904 |
| 19 | ELSIE | 10 | 604 | 75 | 900 |
| 20 | KIM | 7 | 604 | 80 | 908 |
| 21 | ELAINE | 9 | 604 | 68 | 908 |
| 22 | ANGELA | 9 | 604 | 89 | |
| 23 | OLGA | 6 | 603 | 70 | 904 |
| 24 | VIOLA | 7 | 603 | 69 | 897 |
| 25 | CHARLOTTE | 10 | 603 | 59 | 905 |
| 26 | HOPE | 7 | 603 | 79 | 898 |
| 27 | NESLON | 10 | 603 | 88 | 898 |
| 28 | PAMELA | 11 | 603 | 54 | 906 |
| 29 | CARLA | 11 | 603 | 50 | 908 |
| 30 | GORDON | 7 | 603 | 79 | |
| 31 | ELSIE | 10 | 603 | 89 | |
| 32 | JOAN | 10 | 601 | 70 | 901 |
| 33 | NORA | 10 | 601 | 73 | 877 |
| 34 | NINA | 11 | 601 | 87 | 891 |
| 35 | BETTY | 8 | 601 | 87 | 891 |
| 36 | VIRGINIA | 6 | 601 | 57 | 910 |
| 37 | EMMA | 11 | 601 | 67 | 908 |
| 38 | TRIX | 10 | 601 | 54 | 910 |
| 39 | JOAN | 8 | 594 | 59 | 891 |
| 40 | NADINE | 7 | 594 | 71 | 893 |
| 41 | PATSY | 10 | 594 | 73 | 898 |
| 42 | ABBY | 8 | 594 | 83 | 888 |
| 43 | MAC | 10 | 594 | 82 | 888 |
| 44 | PEGGY | 7 | 594 | 86 | 900 |
| 45 | DINAH | 8 | 594 | 87 | 910 |
| 46 | GRACE | 8 | 594 | 58 | 904 |
| 47 | IDA | 8 | 594 | 54 | 892 |
| 48 | BESS | 11 | 594 | 52 | 910 |
| 49 | CARLA | 10 | 592 | 67 | 901 |
| 50 | LOUISE | 11 | 592 | 76 | 895 |
| 51 | IRMA | 11 | 592 | 81 | 902 |
| 52 | BILL | 11 | 592 | 84 | 909 |
| 53 | DOT | 10 | 592 | 85 | 897 |
| 54 | KIT | 6 | 592 | 53 | 902 |
| 55 | WYNNE | 10 | 593 | 80 | 890 |
| 56 | AGNES | 9 | 593 | 68 | 904 |
| 57 | FORREST | 9 | 593 | 83 | 883 |
| 58 | MARGE | 11 | 593 | 83 | 896 |
| 59 | IDA | 9 | 593 | 58 | 873 |
| 60 | JUDY | 8 | 593 | 79 | 887 |
| 61 | SALLY | 9 | 591 | 64 | 894 |
| 62 | TIP | 10 | 591 | 79 | 870 |
| 63 | ELSIE | 9 | 591 | 81 | 893 |
| 64 | IRMA | 12 | 591 | 89 | |
| 65 | VIOLET | 10 | 584 | 61 | 882 |

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 66 | VERA | 9 | 584 | 59 | 896 |
| 67 | LYNN | 10 | 584 | 87 | 898 |
| 68 | MAC | 10 | 584 | 82 | 895 |
| 69 | NANCY | 9 | 584 | 61 | 882 |
| 70 | GILDA | 11 | 584 | 67 | 890 |
| 71 | ELSIE | 9 | 583 | 69 | 890 |
| 72 | KIM | 12 | 583 | 86 | 905 |
| 73 | BESS | 9 | 583 | 79 | 901 |
| 74 | HOLLY | 9 | 573 | 87 | 898 |
| 75 | JUNE | 11 | 582 | 75 | 876 |
| 76 | ANDY | 4 | 582 | 89 | |
| 77 | THERESE | 7 | 581 | 76 | 903 |
| 78 | VANESSA | 10 | 581 | 84 | 879 |
| 79 | LOLA | 11 | 581 | 57 | 896 |
| 80 | RITA | 10 | 572 | 78 | 878 |
| 81 | KAREN | 11 | 572 | 62 | 897 |
| 82 | LOLA | 5 | 571 | 86 | 910 |
| 83 | OPAL | 11 | 234 | 64 | 903 |
| 84 | AMY | 5 | 223 | 71 | 895 |

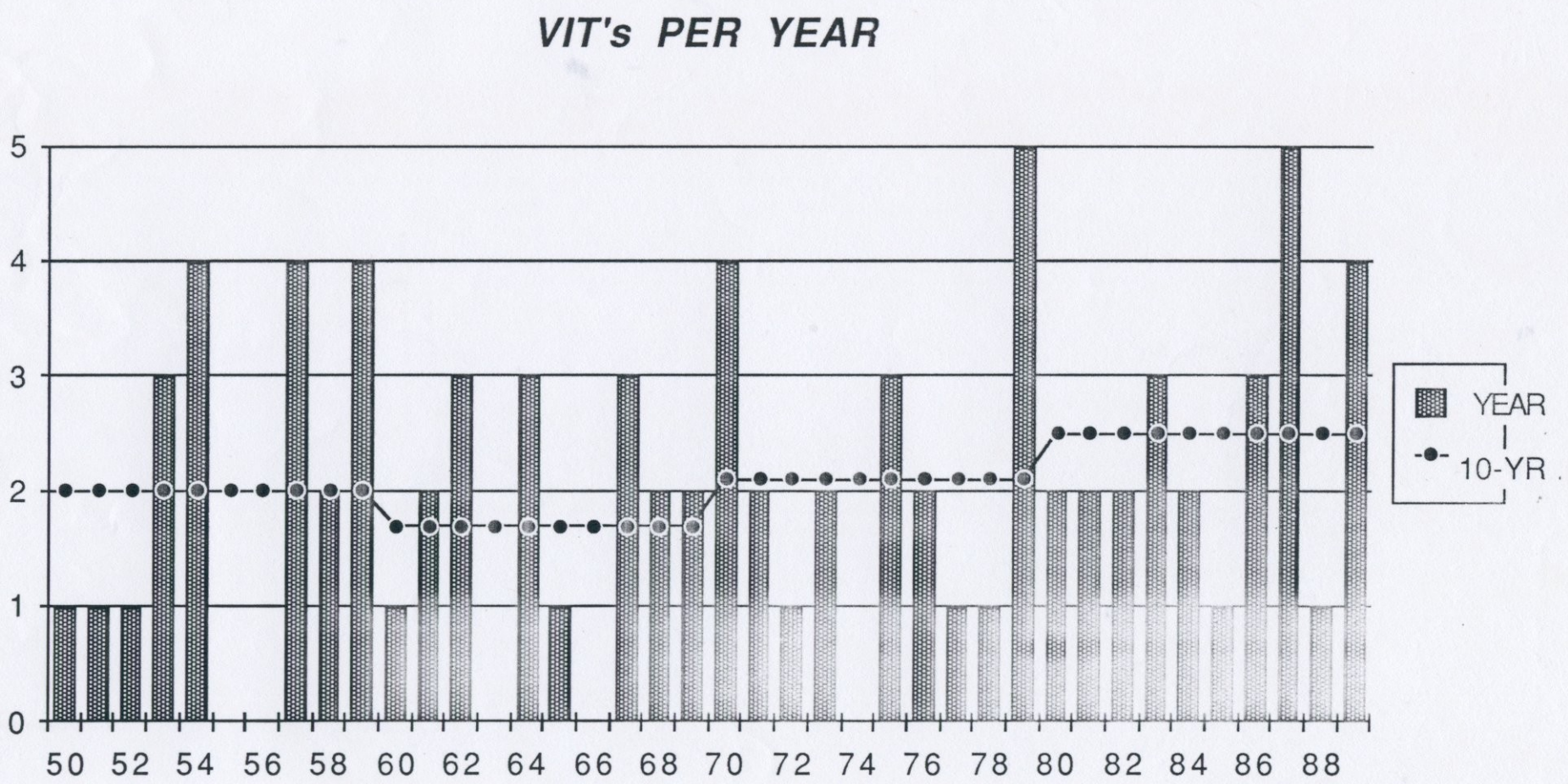
VIT's PER YEAR
5
4
3
2
1
0
50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88
YEAR
10-YR

Figure 5